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Cincinnati, Ohio

1958

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EFFECTS OF THE 1956 STEEL STRIKE ON AIR POLLUTION LEVELS IN SEVERAL COMMUNITIES

by

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EFFECTS OF THE 1956 STEEL STRIKE ON AIR POLLUTION LEVELS IN SEVERAL COMMUNITIES

This paper reports the results of a study conducted in several steel producing communities during and immediately following the steel strike of July, 1956. Since the decision to undertake this study was made the day after the strike started, measurement of pollutant levels under normal operating conditions had to be made after the strike was settled and the plants were once again operating at full capacity.

With only a short time available to prepare for the sampling program, the study was limited to the following communities: Homestead, McKeesport, Pittsburgh, and Donora, Pa.; East Chicago, Ind.; and Birmingham, Ala. Sampling was carried out by local air pollution or health agencies in all cities except Donora, where a more intensive program was conducted by Community Air Pollution Program personnel.

SAMPLING PROGRAM

A continuous sampling program for the collection of suspended particulate matter was set up in all communities. Samples were collected on a 24-hour basis, utilizing the glass fiber filter and high volume sampler combination developed by the National Air Sampling Network of the United States Public Health Service. Because the strike was soon settled, sampling during the strike period averaged only about two weeks duration. To provide a clean separation between strike and post strike periods, a break in sampling intervened. As soon as the plants were again operating normally, sampling was resumed and continued for approximately two weeks (Table 1).

Since the sampling was done during the warm summer months, pollution from home heating plants was not involved. This was fortunate because, in all of the communities studied, large amounts of soft coal are used for domestic heating.

In East Chicago and Pittsburgh use was made of existing National Air Sampling Network stations. Special sampling stations for this study were set up in residential areas in Homestead and McKeesport and at selected sites in Birmingham and Donora. An additional special sampling station was set up in East Chicago.

Monongahela River Valley, Pennsylvania

Six sampling stations were operated in the Monongahela Valley industrial area which produces almost one-fourth of the steel made in this country (Figs. 1 and 2). From the maps it can be seen that the samples collected at any one station in the Monongahela Valley may reflect activities of one or more plants depending on weather conditions. The Pittsburgh station was located approximately one mile north to northeast of a large steel plant, at an elevation 50-100 feet higher than the top of the highest steel plant stack. In Homestead the station was centrally located in a residential area directly south and within 3/4 mile of a large steel plant which bounds the town on the north and extends a considerable distance to the east along the Monongahela River. The station was at an elevation about 25 feet above that of the top of the plant stacks. The McKeesport sampler was located directly south of the steel mills which extend for approximately two miles in an east-west direction along the river. All of this industrial area lies within a mile-and-a-

half radius of the station, which was situated at an elevation 50-100 feet above stack height.

In Donora, Station No. 1 was located in an elementary school at an elevation about 50 feet above the river bank level of 765 feet. Station No. 2 was located at the high school on a hill on the west side of the city, at an elevation of about 1100 feet or slightly more than 300 feet above river bank level. Station No. 3 was situated in the Webster Elementary School on the east side of the river and about 50 feet above the river. In addition to sampling for particulate matter, continuous measurement of sulfur dioxide was made at Station 1 (Titrilog) and 3 (Auto-impinger), and of soiling power (COHS) at Station 1.

East Chicago, Indiana (Fig. 3)

Station No. 1 was located in a residential area completely surrounded by steel industry, with the greatest concentration of large plants lying to east and northeast. Station No. 2, the regular Network station, was situated to the south and southeast of the industrial area, with a portion of the steel industry to the west. The sampling stations and steel plants were at the same ground elevation with the result that the levels of the stacks and vents were considerably above the sampling stations.

Birmingham, Alabama

Three sampling stations were set up in the Birmingham area (Fig. 4). Station No. 1 was located at the University Medical Center, a short distance from the center of the business section. Two very large steel

plants were situated 6-8 miles due west, and three smaller plants 1-3 miles northeast. Station No. 2 was located at the Health Center in the City of Bessemer, 5-8 miles SSW of the large plants. Station No. 3 was situated at the Ensley Health Center, immediately adjacent to one large plant and 2-4 miles NE of the other. The elevations of the three stations and the steel plants were about the same as they were all located in the valley area.

ANALYSIS OF SAMPLES

All samples were analyzed for suspended particulate matter and benzene soluble materials, using current network analytical procedures (1). Selected samples (Table 2) were analyzed for (2) antimony, barium, beryllium, bismuth, cadmium, copper, chromium, cobalt, iron, lead, manganese, molybdenum, nickel, tin, titanium, vanadium, zinc, chlorides, nitrates, and sulfates.

Suspended Particulate Matter

Figure 5 shows the ranges and average levels of suspended particulate matter at each sampling station for the period it operated and for a similar period following resumption of full operations by the steel plants. One outstanding feature of the strike period is the similarity of average levels and ranges observed at the stations within each community. Noteworthy also are the narrow ranges of values shown during the shutdown in all communities except East Chicago. The deviation in the East Chicago area possibly can be attributed to other industrial activities not affected by the strike. The resumption of activity in the steel mills was immediately reflected in the levels of suspended particulate

matter picked up in all communities. The ranges of levels became much wider, except in the Allegheny County communities where increases in the maximum levels were somewhat less than in the other areas. The average particulate level for all communities during the strike period was 111 $\mu g/m^3$, compared to an average of 219 $\mu g/m^3$ for the post strike period. At eight of the eleven stations, all samples collected during the strike gave values below the average of the post strike period. Comparison of the averages and frequency distributions of the particulate levels for the two periods shows very clearly the lower values prevalent in all communities during the strike period (Table 3).

Figure 6 shows daily particulate levels found during the study at Donora station No. 3. Daily variations at other stations followed the same general pattern.

Organic Matter

The amount of benzene-soluble organic materials was measured in all samples by standard extraction procedures (3). The findings (Fig. 7) are similar to those for suspended particulate matter, in that the ranges of values during the strike period were considerably less than those found after the plants were again operating. In most cases the minimum values found in the two periods did not differ greatly, but the maximum levels occurring during the strike, except at McKeesport, were much lower than those of the post strike period. Some stations reflected only slight differences in average values for the two periods, because of the relatively infrequent occurrence of extremely high levels. At seven of the eleven stations, all samples collected during the strike

period presented levels of organic matter below the average of the post strike samples. Variations in averages and frequency distributions of the organic levels are similar to those for suspended particulates and show clearly the influence of the strike (Table 4).

Inorganic Matter

No differences between the two sampling periods were found in levels of antimony, barium, beryllium, cobalt, molybdenum, and nitrate. Bismuth, cadmium, copper, chromium, manganese, nickel, tin, titanium, vanadium, and chloride levels during the strike were lower than afterward at half or more of the stations. At all stations the average levels of lead, iron, zinc, and sulfate found during the strike were markedly lower than during the post strike period (Table 5). For iron and zinc in particular the strike period levels were only a fraction of those found under the post strike conditions. The low levels of zinc found in the Donora samples collected during the strike are of particular interest, since the major industrial activity closed down in that area by the strike involved the use of large quantities of zinc.

SOILING POWER

A continuous measurement of the soiling power of the Donora atmosphere by six-hour periods (beginning at 10 and 4, A. M. and P. M.) was made at Station No. 1, using the AISI Sampler (4,5). The average COH value (per 5000 lineal feet) for the strike period was 3.0, with a range of 0.7 to 6.9. For the post strike period, the average was 6.1, with a range of 1.9 to 14.6. Of the sampling periods during the strike 60 percent had COH values below 3, while only 9 percent of the post strike samples were below that value (Table 6).

SULFUR DIOXIDE

No significant amounts of sulfur dioxide were found in the Donora atmosphere during either sampling period. This may be attributed to the fact that both periods occurred in the non-heating season. Since the Donora atmosphere was so responsive to changes in sources of particulate loading, it may be concluded that the plants closed by the strike were not, in the summer of 1956, major sources of sulfur dioxide.

METEOROLOGICAL DATA

In an attempt to determine if the weather was a major factor in the study, meteorological data for the two sampling periods from Chicago Midway Airport, Greater Pittsburgh Airport, and the Birmingham Municipal Airport were analyzed. Wind data for the three areas were not greatly different for the two sampling periods (Figs. 8,9,10). Rainfall data (Table 8) from Pittsburgh indicated that the August period was somewhat more conducive to the accumulation of pollutants in that area, while Birmingham and Chicago rainfall data indicated that the August period was less conducive to the accumulation of pollutants in those communities. From an examination of these data it would appear that the weather conditions during the strike period and the post strike period were not greatly different. Some variation in the air quality measurements could possibly be assigned to meteorological influences, but there is no reason to suspect that these would account for the order of magnitude of difference shown by the air quality data for the separate periods.

STATISTICAL EVALUATION OF THE DATA

Certain of the foregoing data were examined by the median test method of Mood (6) to determine whether the differences noted were statistically significant. Briefly, the median test involves a determination of the number of observations, m_1 of the strike period, and m_2 of the post strike period, that exceed the median of the combined periods. The exact probability of obtaining by chance the observed or larger differences between the two periods was then computed using the method described by Leslie (7). These probabilities are listed in Table 7 for suspended particulate, organics, copper, iron, lead, manganese, zinc, and sulfate levels in each of the four communities. If the computed probability is .05 or less, it can be concluded that the levels during the strike period were significantly lower than in the post strike period. This occurred in 20 of the 32 instances computed. In the other 12 instances, there is a possibility that the cause of the differences observed may have been other than the shutdown of the plants.

SUMMARY

1. Lower levels of suspended particulate matter were found in the four communities while the steel mills were shut down as a result of the strike of July, 1956, than after the mills resumed operation. The differences in levels were found to be statistically significant.
2. While the gross data appear to show corresponding differences in the levels of organic materials, statistical analysis of these data show that only in Allegheny County and Donora were the levels significantly lower during the strike period.

3. No differences in levels of antimony, barium, beryllium, cobalt, molybdenum, and nitrate were observed during the two periods. Bismuth, cadmium, chromium, nickel, tin, titanium, vanadium, and chloride levels were apparently lower in most of the communities during the strike. Statistical analysis of data for iron, zinc, manganese, lead, sulfates and copper demonstrated that significantly lower values were found during the strike period in the following instances: iron and zinc in all communities; manganese in Birmingham and Donora; lead in Donora and East Chicago; sulfates in Allegheny County and Donora; copper in none of the communities.

4. In Donora it was found that the soiling power of the air during the strike period was half that of the post strike period.

CONCLUSIONS

The effects of the 1956 steel strike on the levels of atmospheric pollutants in four communities have been discussed in this paper. Here, for the first time, have been presented actual quantitative data regarding the differences in amounts and composition of suspended particulate pollutants resulting from the shutdown of steel mills in the major steel producing areas. The fact that lower levels were found during the strike period was not in itself surprising. On the other hand the occurrence of occasional high levels during the strike period indicates that there are sources contributing to pollution of the air which may not be obvious in the presence of an industry which is frequently looked upon as the major offender.

ACKNOWLEDGEMENT

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Table 1. SAMPLING DATES

Community	Strike period	Post strike period
Birmingham	July 16 - 31	August 20 - Sept. 5
Donora	July 13 - 27	August 14 - 30
East Chicago	July 10 - 31	August 7 - 31
Homestead	July 12 - 26	August 7 - 16
McKeesport	July 16 - 26	August 7 - 22
Pittsburgh	July 9 - 27	August 6 - 23

Table 2. SAMPLE INVENTORY

Community	Station	No. of samples collected and analyzed for particulate and organic matter		No. of samples analyzed for inorganic constituents	
		Strike period	Post strike period	Strike period	Post strike period
Birmingham	1	16	17	0	0
	2	16	16	0	0
	3	16	17	9	9
Donora	1	14	15	5	5
	2	15	10	5	5
	3	15	16	5	5
East Chicago	1	17	20	0	0
	2	15	20	9	9
Homestead		11	8	4	4
McKeesport		9	11	3	4
Pittsburgh		15	13	4	4

Table 3. FREQUENCY DISTRIBUTION OF SUSPENDED PARTICULATE LEVELS

Community and period	Average, $\mu g/m^3$	Percentage of samples in indicated range of $\mu g/m^3$					
		0-99	100-199	200-299	300-399	400-499	500+
Birmingham							
Strike	128	35.4	60.4	4.2			
Post strike	184	32.0	30.0	20.0	12.0	6.0	
Donora							
Strike	92	70.5	29.5				
Post strike	249	2.4	31.7	41.5	14.6	9.8	
East Chicago							
Strike	141	25.0	59.4	15.6			
Post strike	279		25.0	42.5	20.0	10.0	2.5
Allegheny County							
Strike	91	71.5	28.5				
Post strike	183	15.7	43.7	40.6			

Table 4. FREQUENCY DISTRIBUTION OF ORGANIC PARTICULATE LEVELS

Community and period	Average, $\mu g/m^3$	Percentage of samples in indicated range of $\mu g/m^3$				
		0-4.9	5.0-9.9	10-19.9	20-29.9	30+
Birmingham						
Strike	6.0	42.6	46.8	10.6		
Post strike	8.7	38.8	34.7	16.3	8.2	2.0
Donora						
Strike	4.5	66.0	34.0			
Post strike	9.5	12.3	51.2	34.1	2.4	
East Chicago						
Strike	4.3	68.7	31.3			
Post strike	8.7	22.2	52.8	19.4	2.8	2.8
Allegheny County						
Strike	5.0	57.2	42.8			
Post strike	9.5	15.6	43.8	37.5	3.1	

Table 5. INORGANIC ATMOSPHERIC POLLUTANTS

Community	Period	Average levels, $\mu g/m^3$			
		Lead	Iron	Zinc	Sulfate
Birmingham	Strike	0.3	1.6	0.2	10.0
	Post strike	0.6	6.2	0.7	13.0
Donora	Strike	0.3	0.4	0.1	10.9
	Post strike	0.8	4.3	11.8	26.6
East Chicago	Strike	0.4	1.4	0.3	15.1
	Post strike	1.1	3.7	1.6	21.4
Allegheny County	Strike	0.3	0.4	0.1	13.1
	Post strike	0.6	1.3	1.1	23.3

Table 6. FREQUENCY DISTRIBUTION OF COH VALUES

Donora Station No. 1

	Average COHS per 5000 lineal feet	Percentage of samples in indicated range					
		0-1.9	2-3.9	4-5.9	6-7.9	8-9.9	10+
Strike period	3.0	27	49	19	5		
Post strike period	6.1	3	22	31	20	16	8

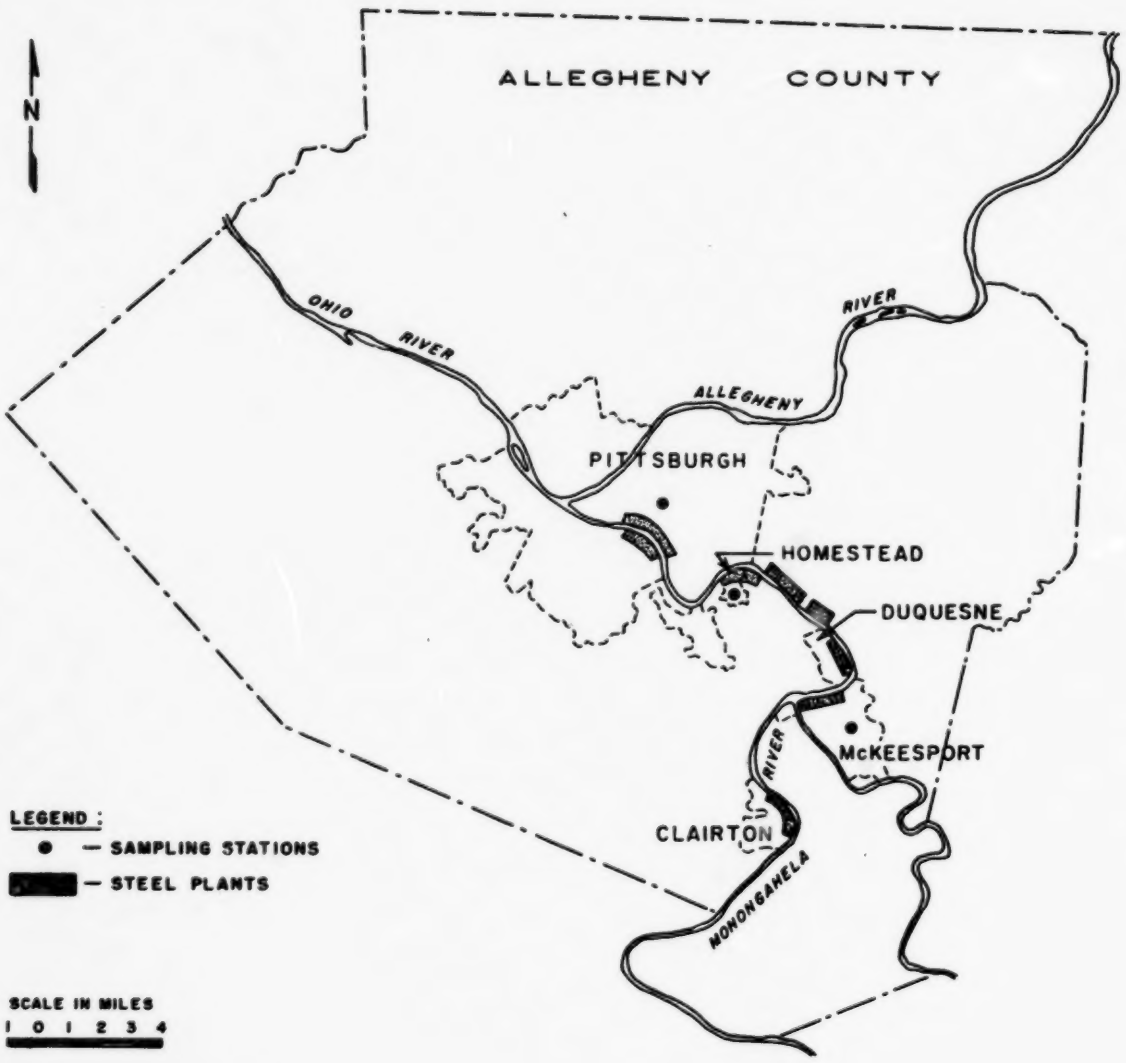
Table 7. PROBABILITY OF OBTAINING THE OBSERVED OR LARGER DIFFERENCES BY CHANCE

Significant values are underscored.

Community	Particulate	Organic	Pb	Fe	SO_4	Mn	Cu	Zn
Birmingham	<u>.057</u>	.571	.173	<u>.028</u>	.173	<u>.028</u>	.173	<u>.028</u>
Donora	<u><.001</u>	<u><.001</u>	<u>.013</u>	<u><.001</u>	<u><.001</u>	<u><.001</u>	.233	<u><.001</u>
East Chicago	<u>.028</u>	.300	<u>.002</u>	<u>.028</u>	.173	.173	.173	<u>.002</u>
Allegheny County	<u><.001</u>	<u><.001</u>	.263	<u>.009</u>	<u>.009</u>	.070	.421	<u>.009</u>

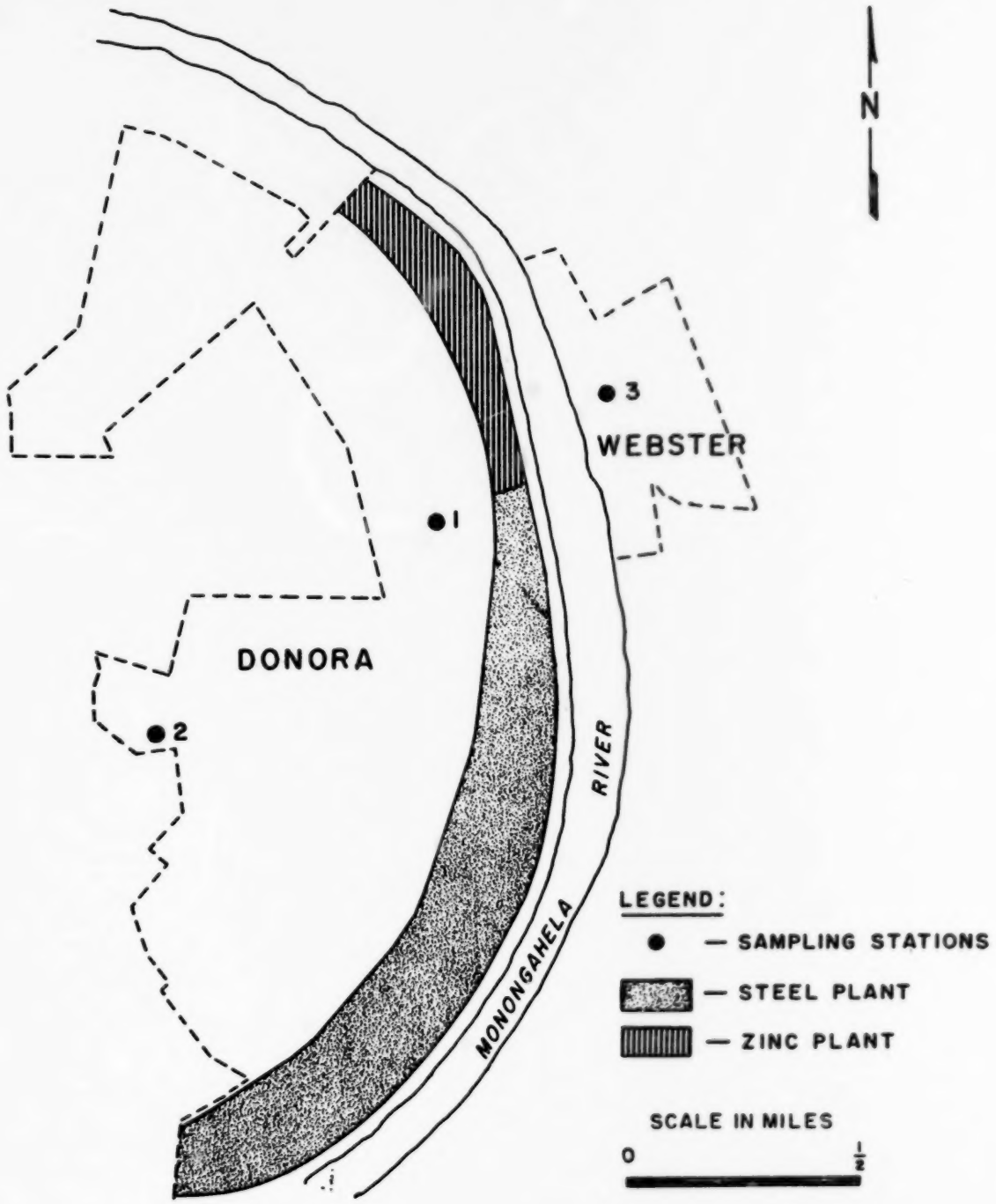
Table 8. RAINFALL DATA

Community	Strike		Post strike	
	Hours of measurable rain	Rainfall, inches	Hours of measurable rain	Rainfall, inches
Birmingham	12	4.20	20	3.07
Chicago	18	1.60	36	4.16
Pittsburgh	19	2.94	11	1.07



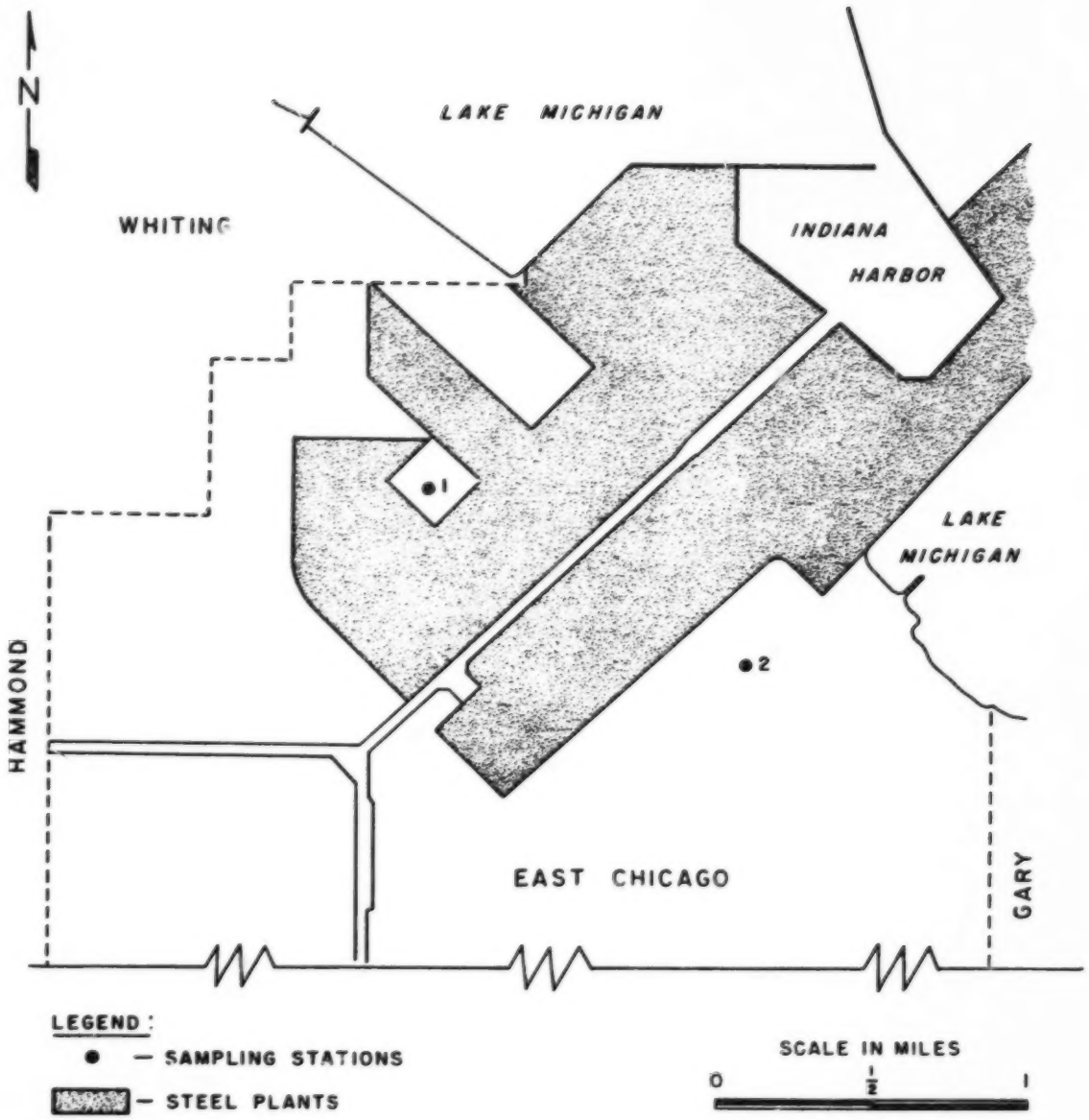
ALLEGHENY COUNTY AREA

FIGURE 1



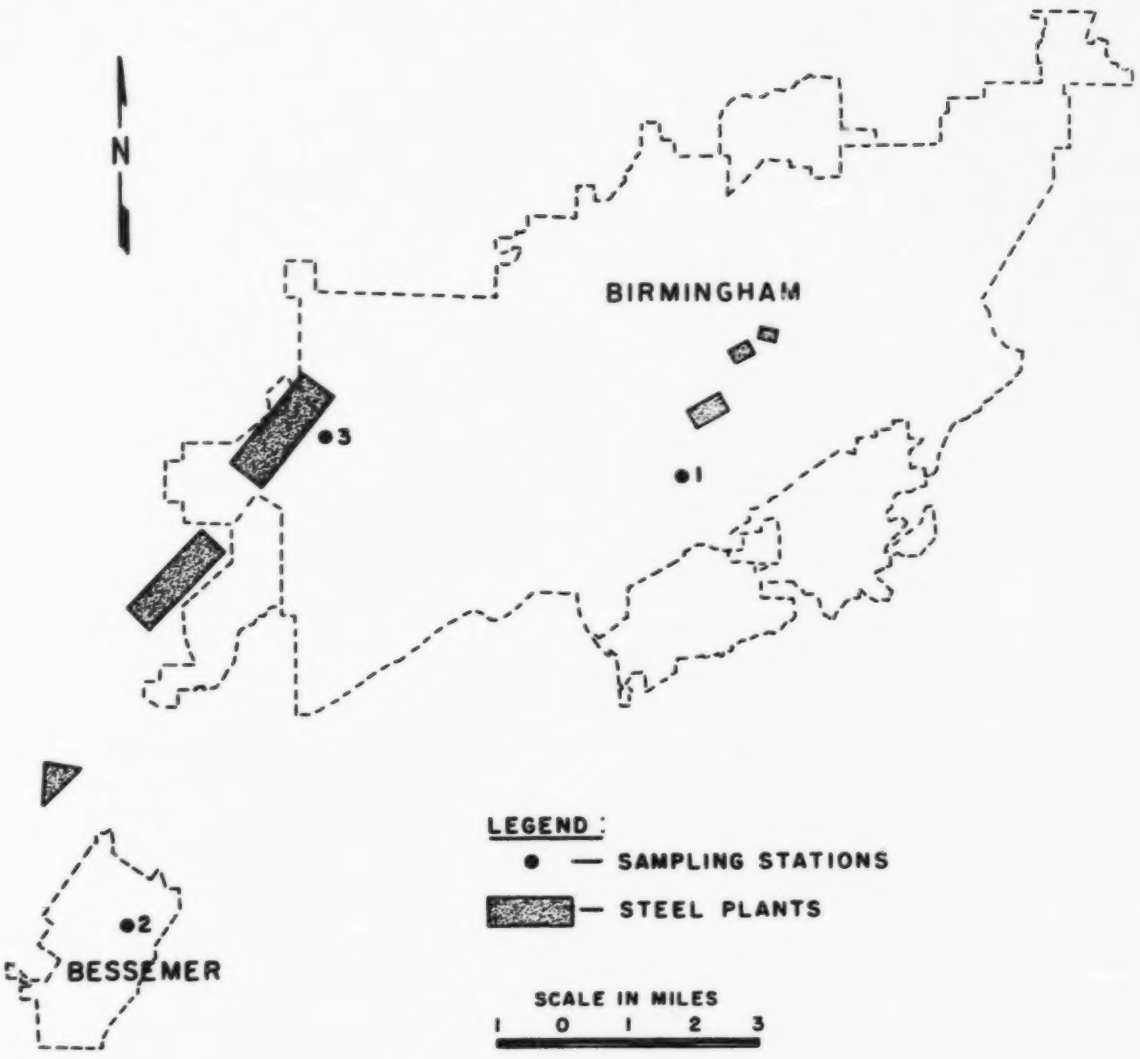
DONORA AREA

FIGURE 2



EAST CHICAGO AREA

FIGURE 3



BIRMINGHAM AREA

FIGURE 4

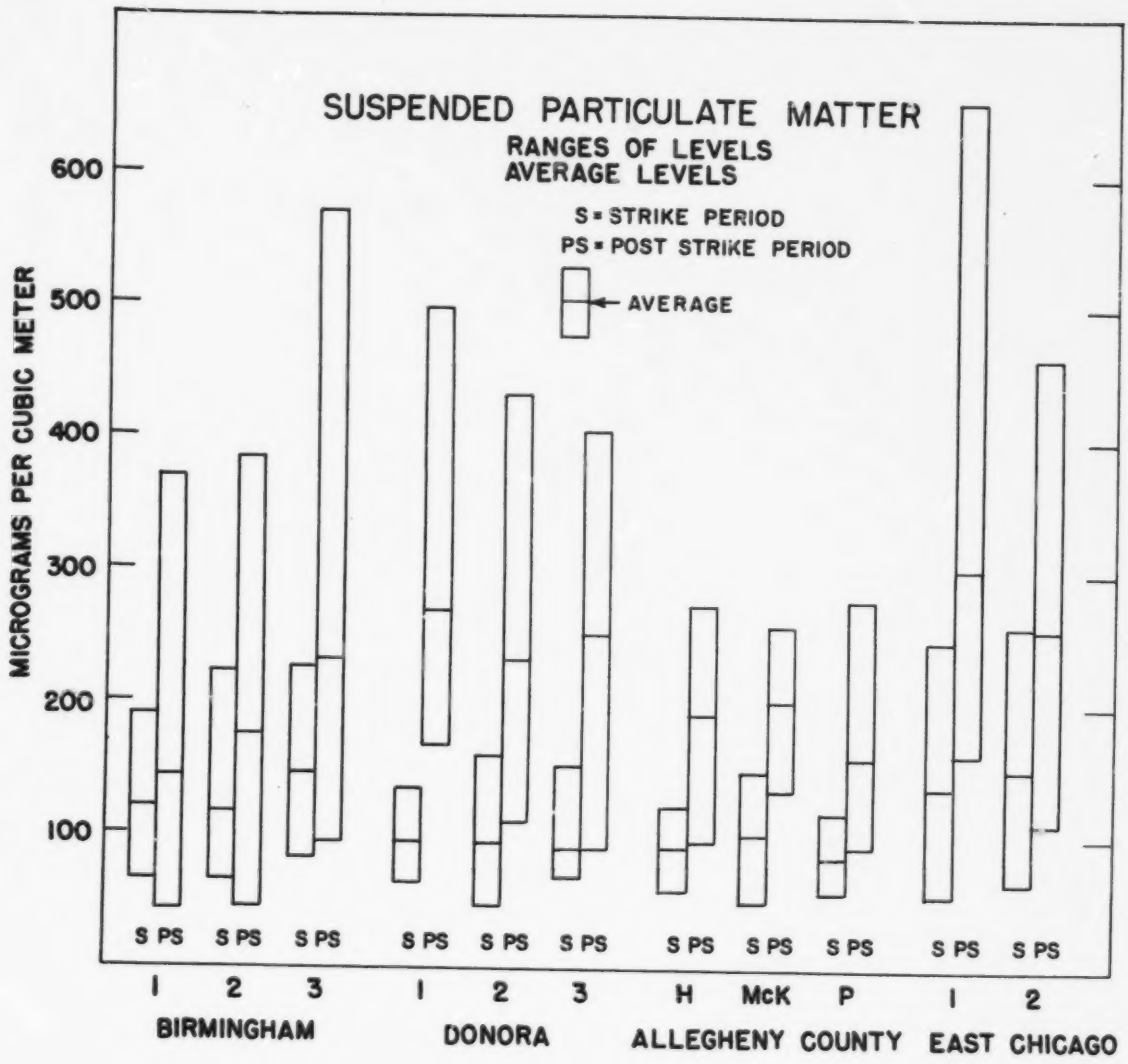

SUSPENDED PARTICULATE MATTER
RANGES OF LEVELS
AVERAGE LEVELS
S = STRIKE PERIOD
PS = POST STRIKE PERIOD
AVERAGE
MICROGRAMS PER CUBIC METER
600
500
400
300
200
100
S PS
1 2 3
BIRMINGHAM
1 2 3
DONORA
H McK P
ALLEGHENY COUNTY
1 2
EAST CHICAGO

FIGURE 5

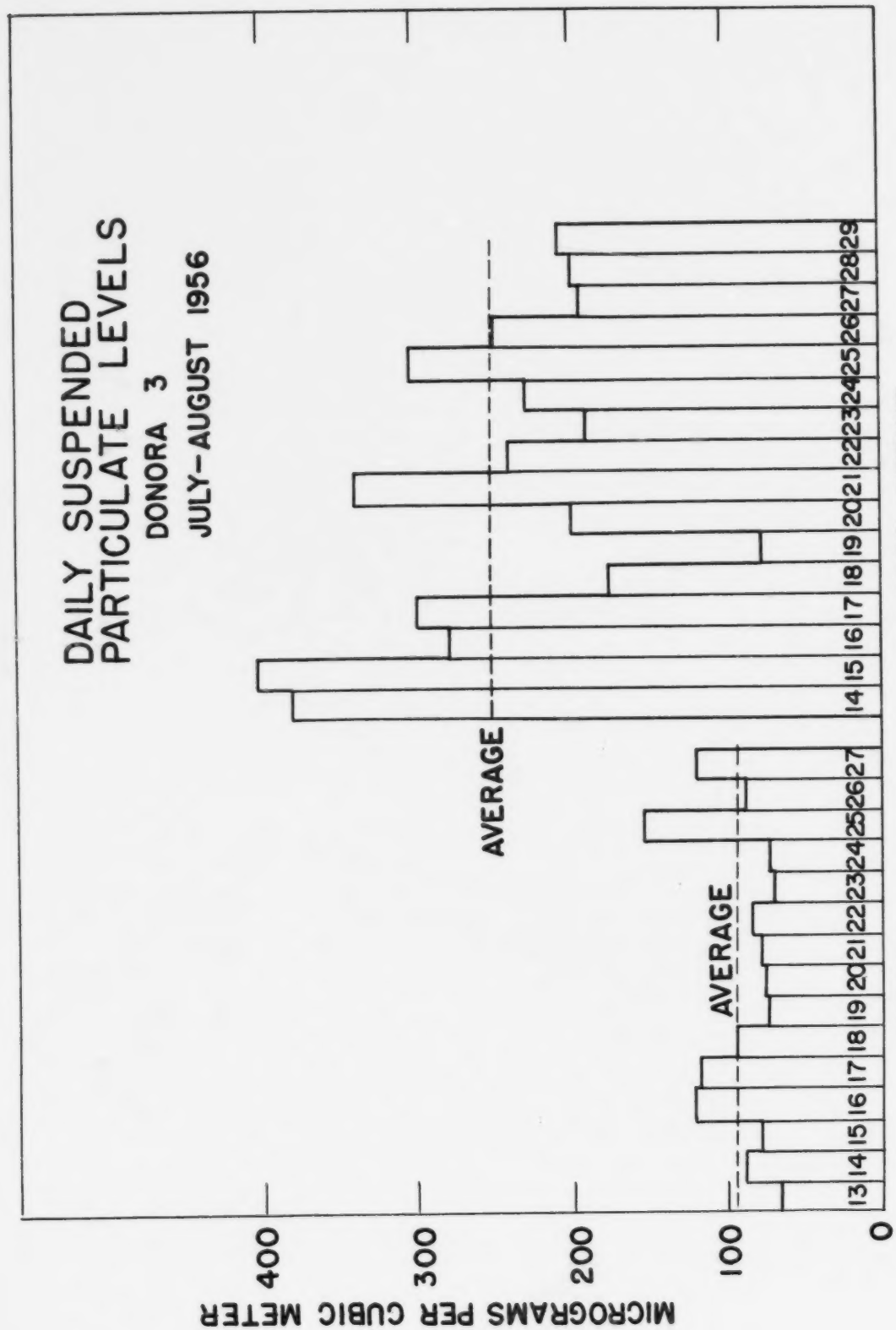
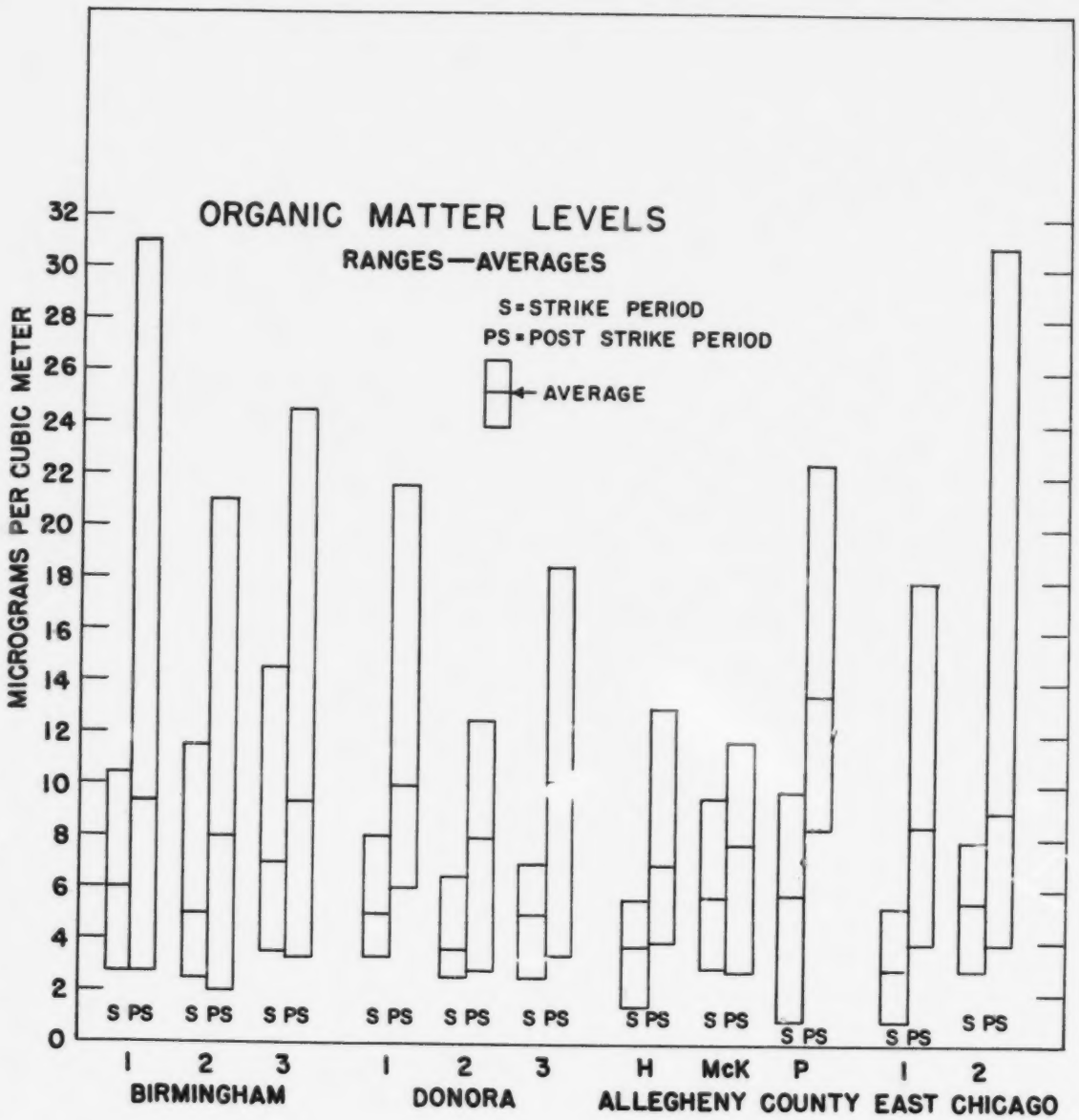

DAILY SUSPENDED
PARTICULATE LEVELS
DONORA 3
JULY-AUGUST 1956
MICROGRAMS PER CUBIC METER
400
300
200
100
0
AVERAGE
AVERAGE
STRIKE
POST STRIKE
13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

FIGURE 6


ORGANIC MATTER LEVELS
RANGES—AVERAGES
S = STRIKE PERIOD
PS = POST STRIKE PERIOD
AVERAGE
MICROGRAMS PER CUBIC METER
0
2
4
6
8
10
12
14
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ALLEGHENY COUNTY
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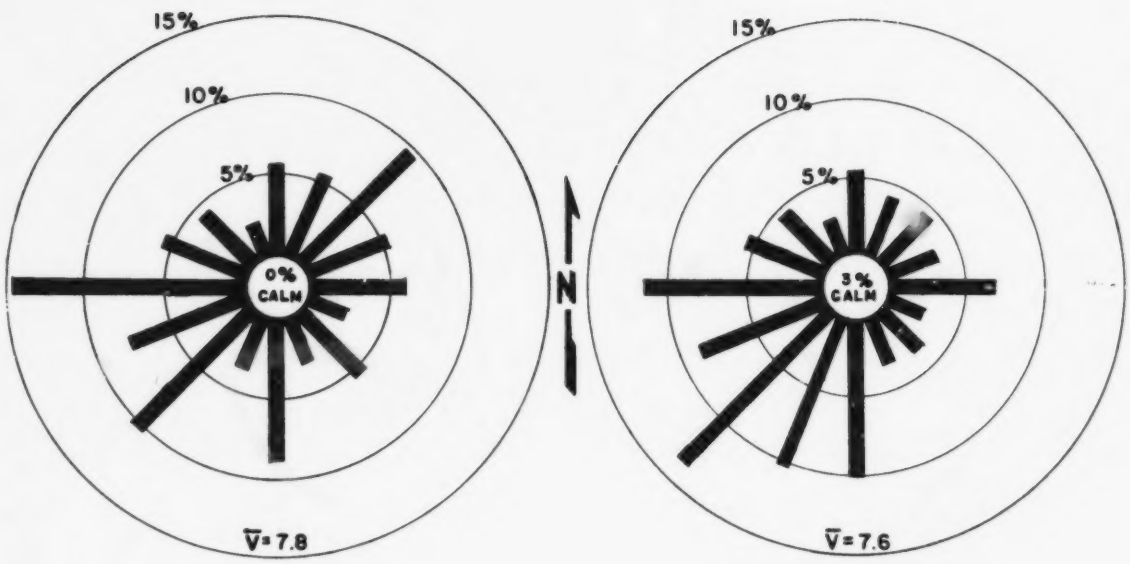
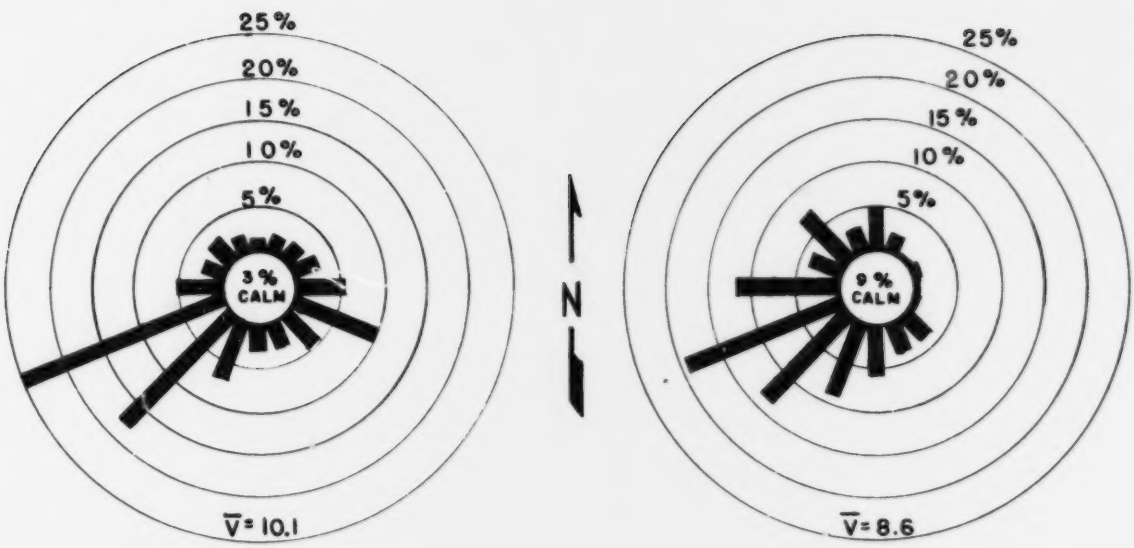
EAST CHICAGO

FIGURE 7



CHICAGO WINDS DURING STUDY

FIGURE 8



JUL. 13–27

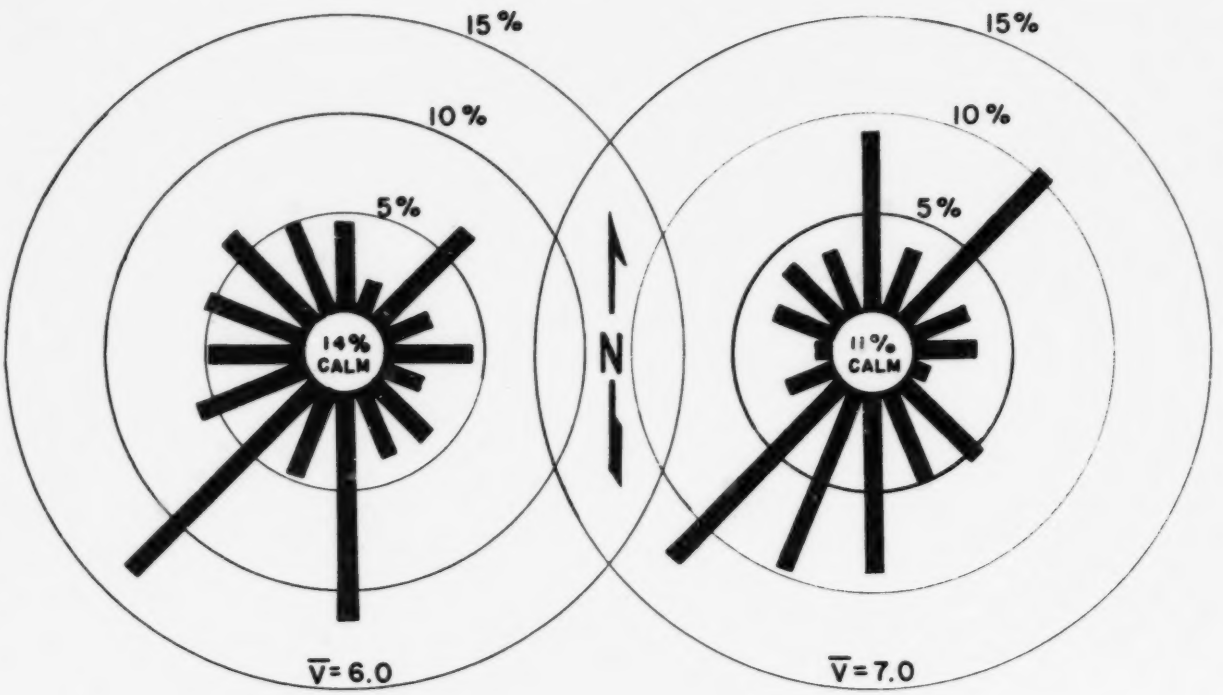
STRIKE PERIOD

AUG. 14–30

POST STRIKE PERIOD

PITTSBURGH WINDS DURING STUDY

FIGURE 9



JUL. 6–31
STRIKE PERIOD

AUG. 20-31
POST STRIKE PERIOD

BIRMINGHAM WINDS DURING STUDY

FIGURE 10